Significant Figures & Rounding
(From Unit 3)

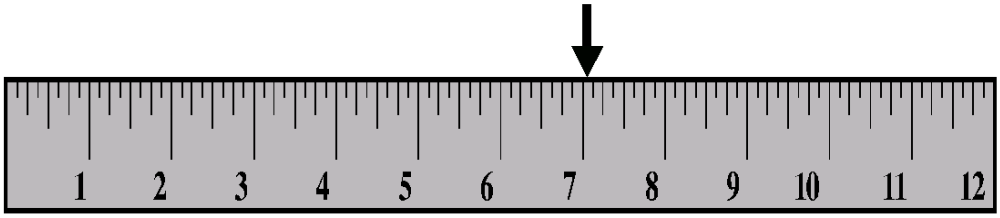
There is no such thing as a perfect measurement

Since all measurements have errors & calculators display meaningless digits, procedures for determining the number of allowed decimal digits are necessary.

➔**Significant numbers apply only to measurements.**

Example: the point below is

Somewhere between 7 and 7 1/8
(7.0 – 7.125)



Point is recorded as 7.08

So ALL measurements record the "certain" (determined by scale on measuring device and then "guess" the "uncertain" or another (beyond scale ability to discriminate) digit.

Certain & Doubtful Digits

	Certain	**Doubtful**
15.25 cm	15.2	5
894.22 g	894.2	2
1.7 L	1	7
36.94 mL	36.9	4
3.1 mg	3	1

Exact Numbers

Numbers that are determined by counting or by definition
("per" expressions are exact)
contain no uncertainty … have infinite or unlimited significant figures.

Examples:

25	6 students
18 apples	491 cars
2.54 cm = 1 in	12 in = 1 ft
100 cm = 1 m	1000 g = 1 kg

Significant numbers do not apply to exact umbers

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Significant Figures

Begin with the first nonzero digit and end with the doubtful digit.
The location of the decimal point has nothing to do with significant figures**.**

Nonzero digits
78.391 km (5 figures) 422.8 gal (4 figures)
Leading zeros - never
0.000391 m (3 figures) 0.00255 g (3 figures)
Captive zeros
7,503 lbs (4 figures) 100,038 cm (6 figures)
Trailing decimal point zeros
14,000 kg (2 figures) 15.60 mL (4 figures) 160. mm (3 figures)
Exact numbers -unlimited
100 cm º 1 m 60 s º 1 min 200 cars

Zero

can be the doubtful digit
can be used to show the decimal

Sscientific notation is often used to indicate significant figures:

example: distance between the earth and the sun is 150,000,000 km

1.5×10^8 km 2 significant
1.50×10^8 km 3 significant
1.500×10^8 km 4 significant

Re-write the quantity 9,340,000,000,000 ps
to show 3 sig. fig. 9.34×10^{12} ps
to show 4 sig. fig. 9.340×10^{12} ps
to show 5 sig. fig. 9.3400×10^{12} ps
to show 6 sig. fig. 9.34000×10^{12} ps

Rounding

Calculators may contain digits that are not significant

If the first digit to be dropped is less than 5, leave the digit before it unchanged.
If the first digit to be dropped is 5 or more, increase the digit before it by 1.

Round ONLY at end of all calculations

Example:

5.324657894
3 significant = 5.32
4 significant = 5.325
5 significant = 5.3247

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Calculations - Multiplication & Division

Round answer to the smallest number of significant figures in any factor:

4.62 m x 3.1 m = 14.322 m^2 (2 significant figures: 14 m^2)

$\frac{248.37}{18.3\ mL}$ = 13.572131 g/mL (3 significant figures: 13.6 g/mL)

Calculations - Addition & Subtraction

Round off the answer to the first column that has a doubtful digit.

	2.22	cm	
	3.9	cm	15.85 g
+	8.9382	cm	- 9.4052 g
	15.0582	cm	6.4448 g
	(15.1	cm)	(6.44 g)

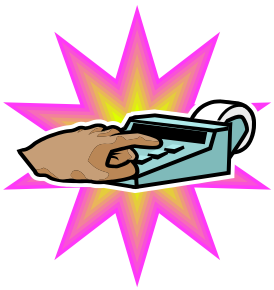
Examples of rounding to appropriate significant figures

$$\frac{2.2745\ g}{3.40\ cm \times 8.1\ cm \times 7.090\ cm} = 1.16487\ g/cm^3 \quad (1.2\ g/cm3)$$

$$95.34\ cm^3 \times \frac{21.3\ g}{cm^3} = 2030.74\ g \quad (2030\ g)$$

$$58.953\ g \times \frac{1\ mL}{0.877\ g} = 67.2212\ mL \quad (67.2\ mL)$$

$$\frac{36.0059\ g}{13.3\ cm^3} = 2.70721\ g/cm^3 \quad (2.71\ g/cm3)$$



	95.202	g	
	12.33	g	42.75 g
+	40.9556	g	- 40.8356 g
	148.4876	g (148.49)	1.9144 g (1.91 g)

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